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Reports
Graham,
R.W.

REPORT ON THE PEDESTRIAN
PALEONTOLOGICAL SURVEY CONDUCTED BY
THE DENVER MUSEUM OF NATURE AND
SCIENCE IN THE PAWNEE NATIONAL
GRASSLANDS, WELD COUNTY, COLORADO

**Report on the Pedestrian Paleontological Survey Conducted by
the Denver Museum of Nature & Science in the Pawnee
National Grasslands, Weld County, Colorado**

Russell Wm. Graham

Museum of Earth and Mineral Sciences
The Pennsylvania State University
University Park, PA 16802
rgraham@ems.psu.edu

and

Bart Weis

Denver Museum of Nature & Science
2001 Colorado Blvd.
Denver, CO 80205
bweis@dmns.org

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INTRODUCTION

The Pawnee National Grasslands (PNG), located in Weld County, Colorado, about 144 km (90 miles) northeast of Denver (Figure 1) is an extremely fossiliferous area that is used for multiple purposes. To this end, the United States Forest Service (USFS), part of the US Department of Agriculture, has been developing a database documenting the location of paleontological resources. As part of this effort, personnel from the Denver Museum of Nature & Science (DMNS) conducted a ten-day, pedestrian paleontological survey in June and July of 2003. USFS staff provided a prioritized list of ten areas (Township, Range and Sections) around the Pawnee Buttes (Table 1) for survey. Some of these areas had been surveyed in the past with known fossil localities in them or adjacent to them. Other areas had never been surveyed before as far as USFS records indicated.

METHODS

Russell Graham, then Chief Curator and Curator of Vertebrate Paleontology at DMNS, served as the principal investigator. Bart Weis was in charge of the field and laboratory aspects of the project. He has been assisted by volunteers from the DMNS PaleoCertification Program. To maximize survey efforts the DMNS survey team concentrated on areas with the greatest exposures of strata (e.g., outcrops and arroyos). At the beginning of each survey period, the team was brought to an exposure along County Road 107 (Fig. 2) where all three units of the White River Group can be seen along with the Upper Ogallala Group. This process allowed each team members to familiarize themselves with the different stratigraphic units that they would be walking

over. So, when material was found by members of the survey crew, they could identify the strata that contained the fossils.

For level or slightly inclined ground surfaces, each survey crew member was spaced two to three meters apart in a straight line parallel to the section lines. Generally, transects were walked in a N\S or E\W direction. Once the end of a section was reached, the crew would return in the opposite direction. This process continued until the section had been completely surveyed. In the cases of arroyos, gullies, or steep outcrops crew members would be positioned on either side of the arroyo and inside the arroyo. Once in position the crew would walk in the direction of the apex of the arroyo. After the arroyo was surveyed the crew would return to the previous position they were at and continue to walk in either a N/S or E/W direction to the section end. Similar techniques were employed when surveying steep outcrops or exposures. When surveying an outcrop the crew would be positioned at different elevations along the exposure and follow that elevation-contour. If an exposure was too steep to walk, binoculars were employed to survey the out crops for fossils.

Each member of the survey team carried pin flags that were used to identify and mark fossil bones or other objects of interest. After the survey of a section was complete, Bart Weis would return with the crew members to marked objects and identify them. Small bone fragments were not collected but noted. All identifiable material was collected. If materials were collected, they were given a field number and relevant data (GPS reading, object id, geologic formation, preferred orientation, *in situ* or float, etc) was recorded in Bart's field book (Table 2). The location was recorded using a hand held

Magellan Sportrak Map GPS set to the datum of NAD 27. Specimens were either bagged or jacketed and labeled with their field number.

CONCLUSIONS

In the ten days of survey the crew was able to cover close to half of the ten areas the USFS listed for the Denver Museum of Nature & Science. Sections 25, 22, 24 and 25 were completed, numbers 1 through 4 on Table 1. Of the areas surveyed, there are four that deserve special note:

Area 1 is in NE1/4, SW1/4, section 26, T10N, R60W. This is a highpoint close to the middle of the section. It has extensive exposures of the Upper White River Group. These light tan sandstone exposures have mammal and turtle bone fragments scattered throughout them. Material that was collected or recorded in this area is highlighted in red on Table 2. No large bones (greater the 10 cm) were seen in this area. In one part of Area 1, there is approximately four square meters with many small bone fragments *in situ*. None of these fragments was identifiable.

Area 2 is in NE1/4, NE1/4 section 28, T10N, R60W. This area is an isolated hill in the northeast corner of the section composed of the upper White River Group. Material was found in, and around, the exposed hillsides. Specimens were also exposed in the arroyos surrounding the hill. Material that was collected or recorded in this area is highlighted in turquoise on Table 2. Groupings or concentrations of bones were not observed in this area. Compared to Area 1, Area 2 does not cover as much ground.

Area 3 is in NW1/4, NW1/4 section 28, T10N, R60W. This area is located close to the northwest corner of the section. Again, these materials occur in the upper White River Group but about 10 m below the contact with the Martan Canyon Formation. A

mandible fragment was found *in situ* but it was not collected because of the time and difficulty it would have taken to excavate and jacket it. A loose fragment of bone was collected associated with the mandible. Within a five meter radius of the mandible other material was found. The material was fragmentary but concentrated. This area may be worth further examination in the future as a potential site for excavation. Collected material is highlighted in green on Table 2. No other groupings or concentrations of bones were observed in this area.

Area 4 is in section 22, T10N, R60W. In the upper southwest corner of this section is in an 80 acre parcel that is surrounded by private land. Material was found at the eastern edge of this 80 acre parcel where it is exposed on a slope in the upper White River Group. The slope is 20 m south and east of large cliffs. A nail with flagging tape was found in the ground next to a turtle bone fragment. Weis believes that this is a locality previously recoded by DMNS (Torrick and Stucky 1996). Further survey should be conducted to determine if this area is the only one where significant numbers of bones occur. The material that was collected or recorded in this area is highlighted in blue on Table 2.

SURVEY OF OTHER INSTITUTIONS FOR PNS COLLECTIONS

Fossils have been collected in the area around the Pawnee Buttes for more than 130 years (Evanoff *et al.* 1999). Many institutions have sent expeditions into this area beginning with the work of paleontological luminaries like E. D. Cope, O. C. Marsh, and F. D. Hayden in the 1870s. Part of the purpose of this project was to attempt to locate

other collections from this area and determine if they came from property that is now under the jurisdiction of the USFS. A literature search was conducted to identify collectors and institutions that have worked in northeast Colorado. Then institutions were contacted or their collections searched on line, when possible, to determine if they had collections from the PNG. The results of this survey are given below by institution.

Yale

In August of 1872, O. C. Marsh led the first Yale student expedition to collect vertebrate fossils from the White River Group at the head of Crow Creek near the towns of Hereford and Grover, Colorado. These specimens are in the Yale Peabody Museum. However, these localities are outside the boundaries of the PNG.

Philadelphia Academy of Natural Sciences

As indicated by Tedford (1999: 33), "In 1873 E. D. Cope made the first of two trips to the Pawnee Buttes area east of Marsh's exploration and extended his work further eastward to the head of Cedar Creek in western Logan County, Colorado..." This area crosses some of the PNG property but it is impossible to know the exact location of Cope's (1873, 1874a, 1874b) collecting sites without detailed analysis of his notes and a survey of the area today. This aspect is beyond the scope of this project. Cope's collections are in the Philadelphia Academy of Sciences.

American Museum of Natural History (AMNH)

The AMNH has conducted field work and made collections in northeast Colorado for more than 100 years. This work officially began with W. D. Matthew (1899, 1901,

1909. 1924). Later expeditions were conducted by Childs Frick (1926, 1933, 1937) and his collectors (Frick and Taylor 1971, Skinner and Johnson 1984). Tedford (1999) has revisited many of these localities making more collections and documenting the stratigraphy. Collections made by all of these expeditions have also been studied by Osborn (1904, 1918), Schultz and Faulkenbach (1941), Woodburne (1969), MacFadden (1984) and many others. As best can be determined, especially from the work of Tedford (1999), none of these collections are on PNG property today. However, several of the AMNH localities (Horse and Mastodon Quarry, Clay Quarry, and "Uhl Pit") are on private property but just across the property line from PNG (Tedford 1999).

Denver Museum of Nature & Science (DMNS) (formerly known as Colorado Museum of Natural History and Denver Museum of Natural History)

The DMNS has conducted field work in this area since its beginnings in 1901. However, most of this work has occurred on private land and land that is still in private ownership. However, several surveys have been conducted by DMNS staff (Torrick and Stuckey 1996) or contractors (Paleontological Investigations) who have placed their collections in the DMNS. Catalogued specimens use DMNH as the catalogue acronym because of the former name of this institution. Appendix I lists localities and specimens in these collections.

Colorado University Museum at Boulder (UCM)

The University of Colorado Museum at Boulder has two collections from PNG property. Materials from Pawnee Buttes West (Locality Number 80012) are listed in

Appendix II. Specimens from the other locality, Bones Galore, have already been reported to the USFS in Greeley.

University of California at Berkeley (UCMP)

R. A. Stirton and C. J. Hesse made collections of Tertiary fossils from northeastern Colorado in the 1930s. These materials are in the University of California Museum of Paleontology (UCMP) collections. In a survey of their on line database, four sites can be identified from Weld County that may be on PNG property. They are localities 71042, 71043, 65228, and 65229. Using, the mapping program on their web page, it appears that 71042, 71043 and 65228 could be on PNG property or right on the boundary with private land. The UCMP mapping routine plots sites to the nearest degrees and minutes and not seconds so it is impossible to determine precisely whether they were on PNG property. UCMP should be contacted to verify this information. Locality 65229 is definitely on private land as it is located west of Highway 71.

University of Nebraska State Museum (UNSM)

The University of Nebraska State Museum also has collections of fossil vertebrates from northeastern Colorado but plotting the location of their sites failed to reveal any that are on PNG property.

University of Kansas (UKNMH)

The most recent systematic study of fossils and geology of the northeast Colorado area that has been published is the work of E. C. Galbreath (1953). As previously indicated, Tedford has been working with the Miocene age fossils and geology in the western part of PNG area and Graham has been studying the Chadronian on the eastern side of PNG. Evanoff has been working on the Tertiary geology throughout the entire area. However, as yet a comprehensive publication of these studies has not been completed other than a guide book (Evanoff *et al.* 1999). Graham *et al.* (2003) have submitted a report of their investigations to the USFS in Greeley.

Galbreath (1953) provides detailed locality information for all of his material as well as material he studied from the AMNH. We have plotted all of these localities and none of them are on PNG properties.

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Table 1. Pawnee National Grasslands ten prioritized areas for survey.

Number	PLSS	Location
1)	Section 26, T10N, R60W	Weld County Colorado
2)	Two 80 acre parcels in Section 22, T10N, R60W	Weld County, Colorado
3)	Southern ½ of Section 24, T10N, R60W	Weld County, Colorado
4)	Section 25, T10N, R60W	Weld County, Colorado
5)	Section 30, T10N, R59W	Weld County, Colorado
6)	Southern ½ Section 20, T10N, R59W	Weld County, Colorado
7)	Section 29, T10N, R59W	Weld County, Colorado
8)	Section 30, T10N, R59W	Weld County, Colorado
9)	U.S.F.S. Land in Sections 21 & 22, T10N, R59W	Weld County, Colorado
10)	Western ½ of Section 28, T10N, R59W	Weld County, Colorado

Table 2. Data recorded with materials collected during the survey.

Site #	Specimen #	Section	Elev.	GPS	Stratum	Sed. Color	Sed. Type	Specimen ID	Taxon	Collected/marked
	1	26	5348	404830, 1040311	twr	Tan	Cs	Frag		
	2	26	5352	404831, 1040324	twr	Tan	Cs	Frag		
	3	26	5336	404833, 1040348	twr	Tan	Cs			
	4	26	5373	404834, 1040317	twr	Tan	Cs			
	5	26	5377	404834, 1040318	twr	Tan	Cs			
	6	26	5365	404833, 1040318	twr	Tan	Cs			
	7	26	5362	404833, 1040318	twr	Tan	Cs			
	8	26	5362	404833, 1040318	twr	Tan	Cs			
	9	26	5362	404833, 1040319	twr	Tan	Cs			
	10	26	5370	404834, 1040318	twr	Tan	Cs			
	11	26	5305	404834, 1040402	twr	Tan	Cs			
	12	26	5398	404834, 1040403	twr	Tan	Cs			
	13	26	5301	404820, 1040318	twr	Tan	Cs			
	14	26	5313	404821, 1040344	twr	Tan	Cs			
	15	26	5300	404819, 1040351	twr	Tan	Cs			
I	I	■	■■■	■■■■■■■■	■	■	■			■
	■	■	■■■	■■■■■■■■	■	■	■			
	■	■	■■■	■■■■■■■■	■	■	■			
	■	■	■■■	■■■■■■■■	■	■	■			

6	1	26	5411	404840, 1040304	twr	Tan	Cs	Pelvis Part	yes
6	3	26	5414	404841, 1040303	twr	Tan	Cs	Long Bone Frag	yes
6	2	26	5404	404840, 1040303	twr	Tan	Cs	Skull	yes
	29	26	5405	404841, 1040303	twr	Tan	Cs	Turtal	
	30	26	5403	404841, 1040304	twr	Tan	Cs		
	31	26	5409	404840, 1040304	twr	Tan	Cs		
	32	26	5401	404840, 1040304	twr	Tan	Cs	Tooth Frag	
	33	26	5395	404841, 1040305	twr	Tan	Cs		
	34	26	5404	404840, 1040303	twr	Tan	Cs		
7	1	26	5408	404841, 1040304	twr	Tan	Cs	Tooth Root	yes
	36	26	5414	404842, 1040304	twr	Tan	Cs		
	37	26	5395	404840, 1040305	twr	Tan	Cs		
8	1	26	5388	404839, 1040305	twr	Tan	Cs	Mandable Frag	yes
9	1	26	5423	404845, 1040309		Tan	Cs	Foot Bone	yes
10	1	26	5431	404848, 1040320		Tan	Cs	Small Skull	yes
	41	26	5439	404848, 1040322	tmc	Tan	Cs	Rhino Rib Frag	
	42	26	5365	404847, 1040400		Tan	Cs		
	43	26	5350	404847, 1040359		Tan	Cs	Turtal	
11	1	26	5350	404847, 1040359		Tan	Cs	Foot Bone	yes

12	1	26	5352	404847, 1040400		Tan	Cs	Teeth Frags		Yes
12	2	26	5354	404847, 1040400		Tan	Cs	Toe Bone		Yes
13	1	26	5358	404847, 1040402		Tan	Cs	Teeth & Jaw Frags		Yes
	48	26	5350	404847, 1040403		Tan	Cs	Bone Frags		
	49	26	5350	404846, 1040403		Tan	Cs	Small Rib Frag		
	50	26	5355	404847, 1040403		Tan	Cs	Rib Frag		
	51	26	5345	404844, 1040358		Tan	Cs	Bone Frags		
14	1	26				Tan	Cs	Bone Frags		Yes
15	1	24	5283	404855, 1040201		Tan	Cs	Small Astraguls		Yes
	54	24	5393	404850, 1040200		Tan	Cs	Small Joint		
	55	24	5362	404850, 1040156		Tan	Cs	Small Bone Frags		
	56	24	5344	404853, 1040154		Tan	Cs	Small Bone Frags		
	57	25	5433	404830, 1040235		Tan	Cs	Small Bone Frags		
	58	25	5430	404820.6, 1040227.8		Tan	Cs	Turtal Fragment		
	■	■	■	■		■	■	■		
	■	■	■	■		■	■	■		

Figure 1. Map showing the location of the Pawnee National Grasslands.

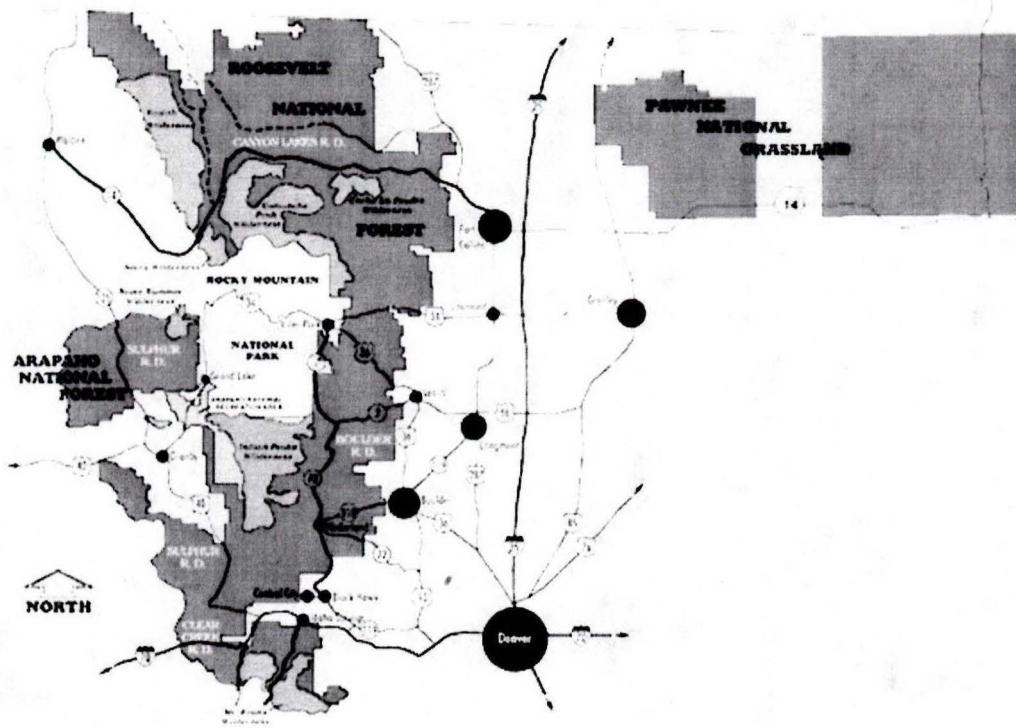


Figure 3. Four areas highlighted in report as potential sites.

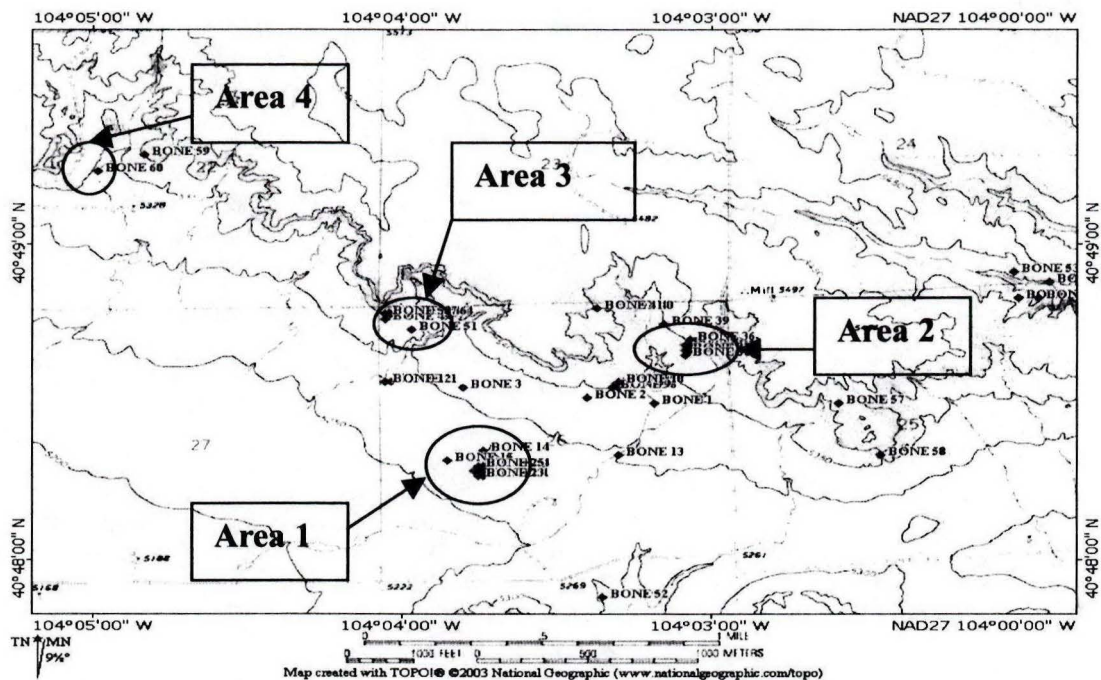
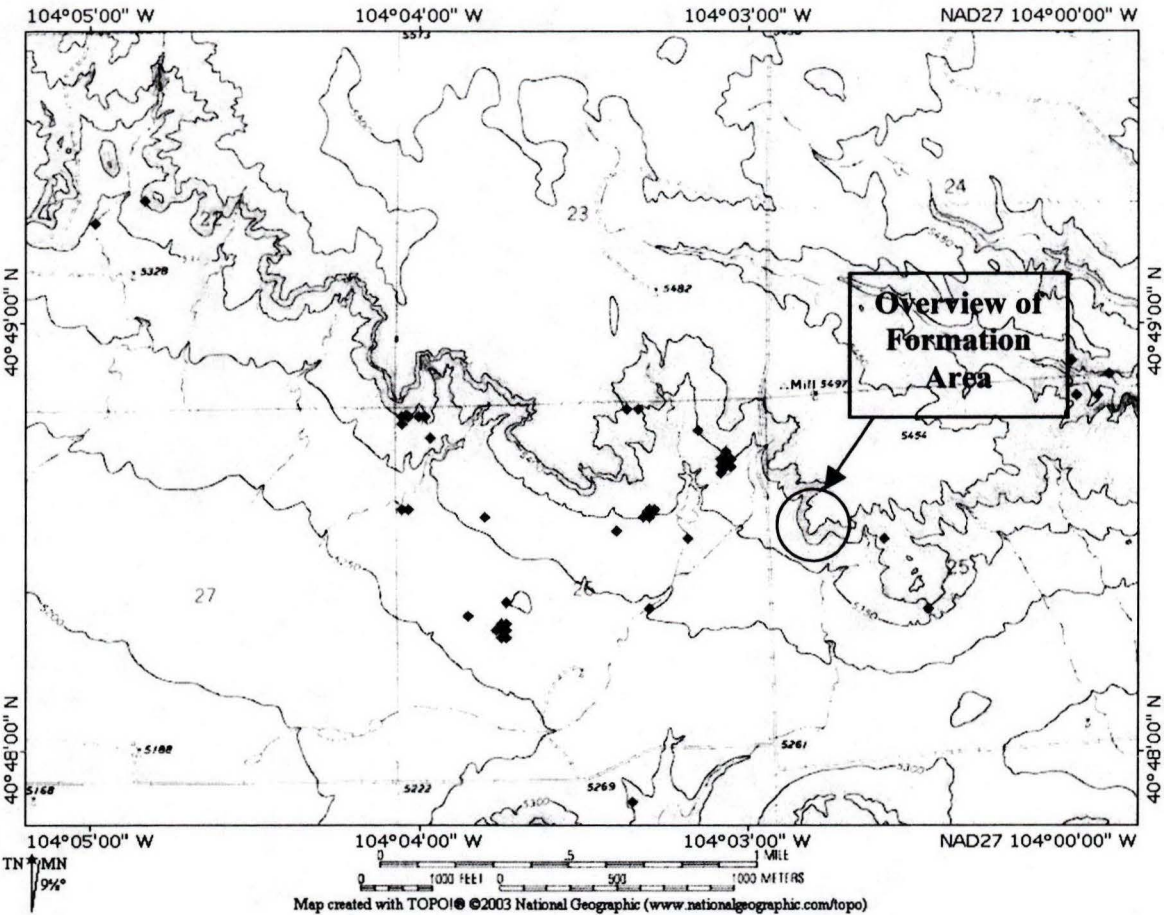


Figure 2 Topographic map of Survey Area, blue dots indicate the localities of bone discovery.



Appendix II. List of specimens from the Pawnee Butte West site (Locality No. 80012) in the University of Colorado Museum at Boulder (UCM) collections. Data provide by UCM at Boulder.

Locality#	Locality Name	County	Section	Township	Range	Map Name
80012	Pawnee Buttes West	Weld	21	10N	59W	Pawnee Butte

UCM #	Class	Order	Family	Description	Collector
42536	Mammalia	Rodentia	Aplodontidae	tooth	K.Carpenter
42537	Mammalia	Rodentia	Aplodontidae	Rt. P/4	K.Carpenter
42538	Mammalia	Rodentia	Eomyidae	Rt. M1/	K.Carpenter
42539	Reptilia	Squamata	Anguidae	scute	K.Carpenter
42540	Reptilia	unknown	unknown	vertebra	K.Carpenter
42541	unknown	unknown	unknown	many misc. bone fragments	K.Carpenter
80762	Mammalia	Primates	Microsyopidae	L/I	UCM Party

Appendix I. List of specimens and catalogue numbers recovered during this survey and housed in the Denver Museum of Nature & Science.